International Journal of Civil Engineering and Technology (IJCIET)
Volume 8, Issue 3, March 2017, pp. 628–636 Article ID: IJCIET_08_03_062
Available online at http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=3
ISSN Print: 0976-6308 and ISSN Online: 0976-6316

MICROSTRUCTURAL STUDY ON HIGH PERFORMANCE CONCRETE MADE WITH M SAND

R. Bhuvaneswari
PG Scholar, Civil Engineering Department,
Karpagam University, Coimbatore, Tamilnadu, India

M. Jagadeesh
PG Scholar, Civil Engineering Department,
Karpagam University, Coimbatore, Tamilnadu, India

E. Ezhilarasi
Assistant Professor, Department of Civil Engineering,
Karpagam University, Coimbatore, India

A. Thangadurai
Assistant Professor, Department of Civil Engineering,
Karpagam University, Coimbatore, India

P. Magudeaswaran
Senior Assistant Professor, Department of Civil Engineering,
Sri Ramakrishna Institute of Technology, Coimbatore, Tamil Nadu, India

ABSTRACT

This paper presents a scanning electron microscopy study performed on high performance concrete made with binary and ternary homogenised cement concretes. Concrete specimens were prepared with manufactured Sand as fine aggregates. The influence of different proportion of mineral admixtures on the microstructure and compressive strength of the concrete were studied. SEM observations discovered that the binary blended cement concrete – cement interfacial zone consisted primarily of loose and porous hydrates whereas the ternary homogenized cement concrete – cement interfacial zone consisted mainly of dense hydrates. The compressive strength results that the concrete ready with ternary alloyed cement was on top of that of the binary homogenized concrete. however the strength development of the HPC binary concrete was quicker than that of the ternary concrete at early ages. At 90 days, the both the concrete achieved similar strength values. The results are explained by the variations in porousness and pore structure of the two type's blends, and potential interactions between the aggregates and also the cement paste

Key words: HPC, M-sand, Microstructure; Interfacial transition zone; Compressive strength.

Cite this Article: R. Bhuvaneswari, M. Jagadeesh, E. Ezhilarasi, A. Thangadurai and P. Magudeaswaran, Microstructural Study on High Performance Concrete Made with M Sand. *International Journal of Civil Engineering and Technology*, 8(3), 2017, pp. 628–636.
http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=3

1. INTRODUCTION

It is well established that the transition zone, the interfacial region between the coarse aggregate and the hydrated cement paste, is the weakest region in the concrete. Most of the concrete strength and durability properties are markedly influenced by the properties of the interfacial zone. As a result, the effects of properties interfacial region on concrete strength and durability of concrete have been the subject of many recent investigations.

Numerous investigations have been carried out to study microstructure of cement paste made with or without mineral admixtures. However, limited work has been directed toward studying the effect of mineral admixtures on microstructure of concrete, especially binary and ternary blended concrete systems.

This research was undertaken to investigate the effects of addition of silica fume and fly ash on concrete microstructure and strength properties. The microstructure of concrete was studied scanning electron microscopic techniques.

2. EXPERIMENTAL INVESTIGATION

2.1. Materials

Ordinary Portland cement of 53 Grade was used and the specific gravity of cement was found to be 3.15. The physical and chemical properties of cement are presented in Table 1.fina aggregates: Locally available natural sand with 4.75mm maximum size was used. Its physical properties are given in Table 2 and conformed to IS: 383 – 1970.M-sand: Available in local market, 4.75mm maximum size. The physical properties are given in Table 2.Crushed stone: Locally available crushed stone with 12.5 maximum size and its physical properties are given in Table 3 and conformed to IS: 383 – 1970.Fly ash is finely divided residue resulting from the combustion of powdered coal and transported by flue gases and collected by electrostatic precipitation. Silica fume is a byproduct of producing silicon metal or ferrosilicon alloys. One of the most beneficial uses for silica fume is in concrete. The silica fume is collected from ELKEM INDIA (P) LTD, Mumbai.Super plasticizer Conplast SP430 complies with IS:9103:1999 and BS:5075 Part 3 and ASTM-C-494 Type 'F' as a high range water reducing admixture and Type G at high dosage is used.Water used was fresh, colorless, odorless and tasteless potable water free from organic matter of any type.

2.2. Mixture Proportions

Control mixture was proportioned to have 28-day compressive strength of 60 MPa in line with ACI 211.4R .The ratio of concrete combine proportion was 1:1.9:2.39; Twelve further concrete mixtures were proportioned where sand (fine aggregate) was absolutely replaced river sand and concrete proportioned by cement with fly ash at the progressive interval 5% and cement with fly ash combined with silica fume at a succeeding rate of 2.5% by mass respectively. All mixtures had constant water-to-cement ratio of 0.33.The dosage of super plasticizer was varied in order that the slump of all mixtures was 85 ± 5 mm.

Table 1 Description of mixes

MIX ID	CEMENT %	SILICA FUME % (A)	FLY ASH % (B)	M SAND %
M1	100	0	0	100
M2	100- A	2.5	0	100
M3	100 - A	5	0	100
M4	100 –A	7.5	0	100
M5	100–A	10	0	100
M6	100 –A	12.5	0	100
M7	100–A	15	0	100
M8	100-A-B	2.5	5	100
M9	100-A-B	5	10	100
M10	100-A-B	7.5	15	100
M11	100-A-B	10	20	100
M12	100-A-B	12.5	25	100
M13	100-A-B	15	30	100

2.3. Specimens Preparation and Casting

All the ingredients of HPC were mixed in a laboratory pan mixer. during the initializing 80% of the total water was added for mixing and after one minute, the remaining water was added and therefore the mixing was continuing for another 2 minutes until a uniform mix was obtained. 100 mm concrete cubes were cast for compressive strength, 150 mm diameter 300 mm high cylinders for split tensile strength. All the specimens were prepared in accordance with BIS: 1199-1959.The test specimens were cast in the processed moulds. The moulds were organized on the vibratorytable for discharge any voids which will be present. The mix was stuffed in 3 layers and every layer was compacted with a 16 mm tamping rod before placing on the vibratory table. The specimens were allowed to cure for twenty-four hours and then cured in water till the day of testing.

3. RESULTS AND DISCUSSIONS

3.1. X-Ray Diffraction (XRD) Analysis

X-ray diffraction (XRD) is one of the most prominent analytical techniques in the characterization of crystalline, fine-grained materials, such as cements. The power of XRD is in the rapid and, if carried out appropriately, reliable delivery of quantitative data on crystal structural properties and abundances of individual phases contained in cements. In cements the technique is mostly used for qualitative, i.e. phase identification, and quantitative phase analysis (QPA). The relatively recent extension to the quantitative study of hydrated cements opens up a wide range of opportunities for ground breaking research in cementitious materials. In the X-Ray Diffraction (XRD) analysis is performed to determine the silica phase of the powder concrete samples. The samples are scanned by an X-Ray diffractometer which is shown in Figure 1.

Figure 1 X-Ray Diffractometer

A small amount of powder sample is put into an aluminum sample holder and the surface is finished smoothly. The holder is then placed into the X-Ray diffractometer. The samples are scanned by an X-Ray diffractometer using CuK radiation at 40 kV / 20 mA, CPS = 1k, width 2.5, speed 2° / min and scanned with an angle of 2 from 3 – 70°. The analysis is stepped at 0.04 degree increments and continued for a period of 3 seconds. In X-Ray diffraction, X-Rays are scattered by atoms in a pattern that indicates lattice spacing of elements present in the material analyzed. Once the X-Ray analysis is completed, the scans are analyzed using Jade 7 – X-Ray Diffraction (XRD) software. Using Jade, peak intensities at different angles are compared with a database of different minerals and compounds. Compounds with peak intensities matching those of the scans are identified and the compounds present in the samples are also determined.

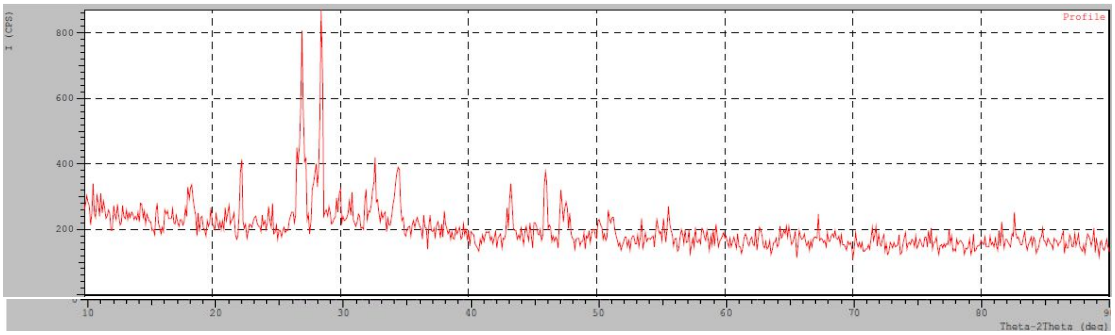

Figure 2 XRD pattern (2 Θ angle) graph of M1

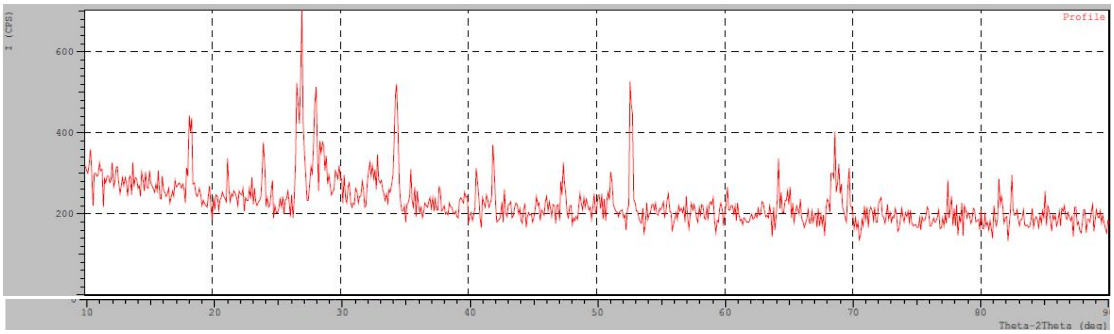

Figure 3 XRD (2 Θ angle) graph of M2

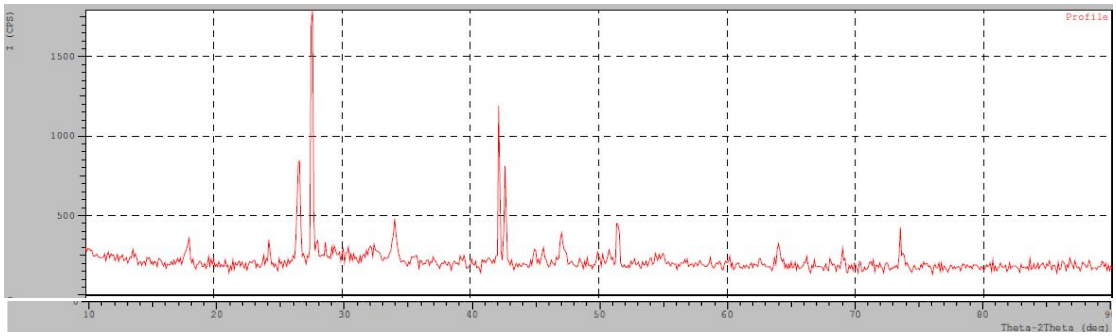

Figure 4 XRD (2 Θ angle) graph of M3

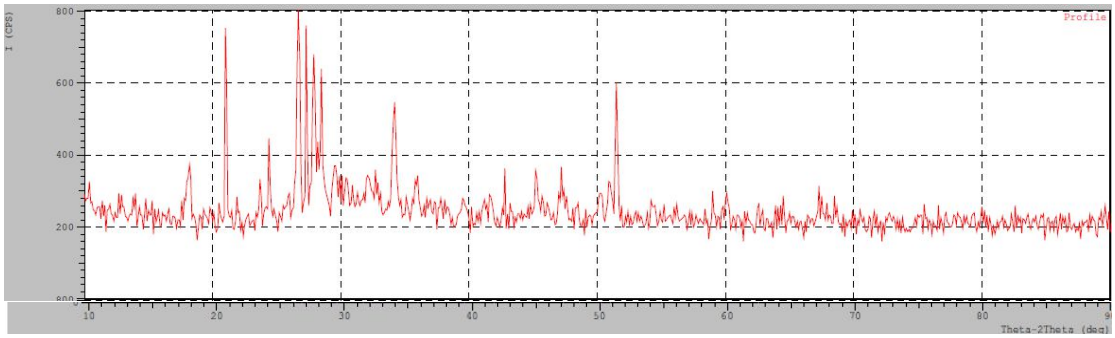

Figure 5 XRD (2 Θ angle) graph of M4

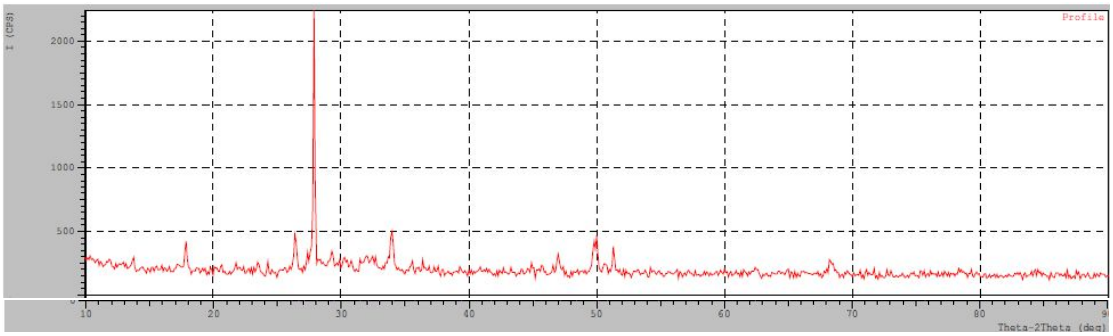

Figure 6 XRD (2 Θ angle) graph of M5

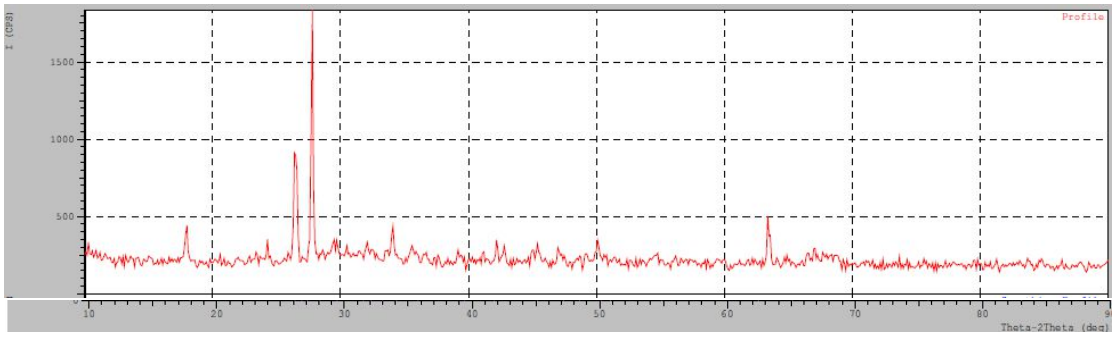

Figure 7 XRD (2 Θ angle) graph of M6

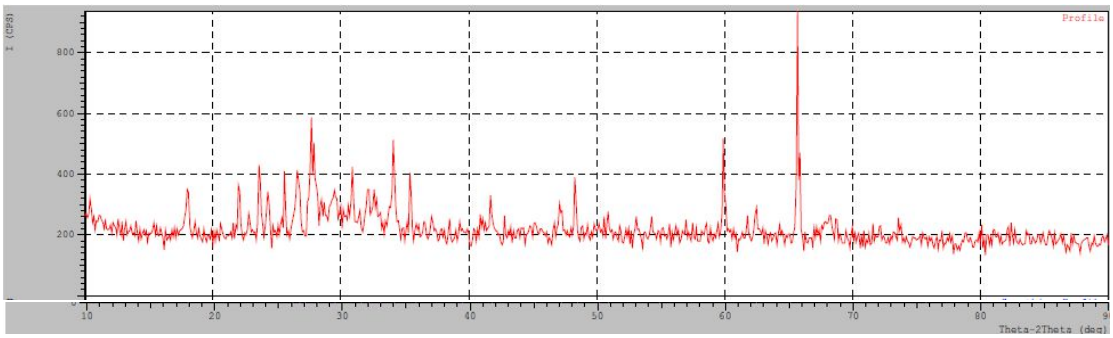

Figure 8 XRD (2 Θ angle) graph of M7

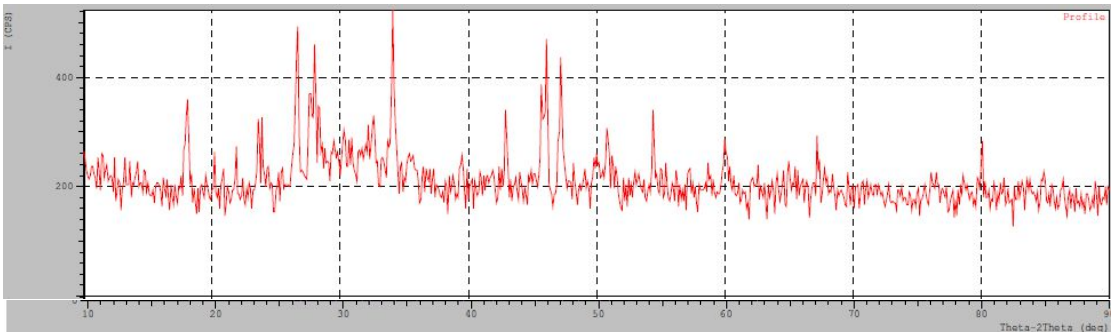

Figure 9 XRD (2 Θ angle) graph of M8

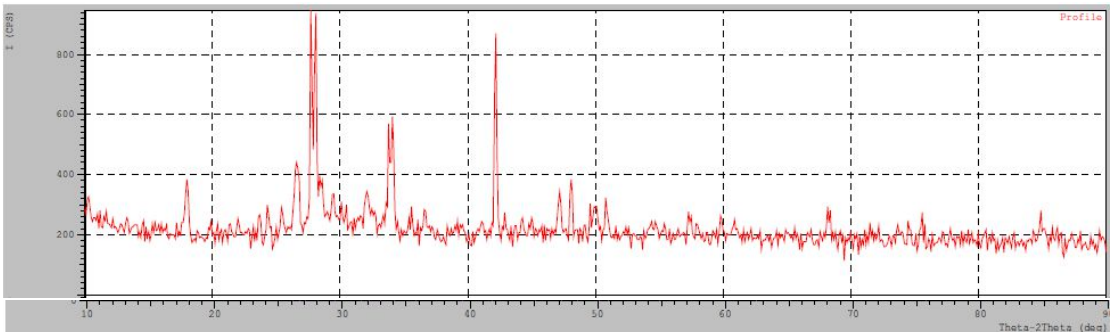

Figure 10 XRD (2 Θ angle) graph of M9

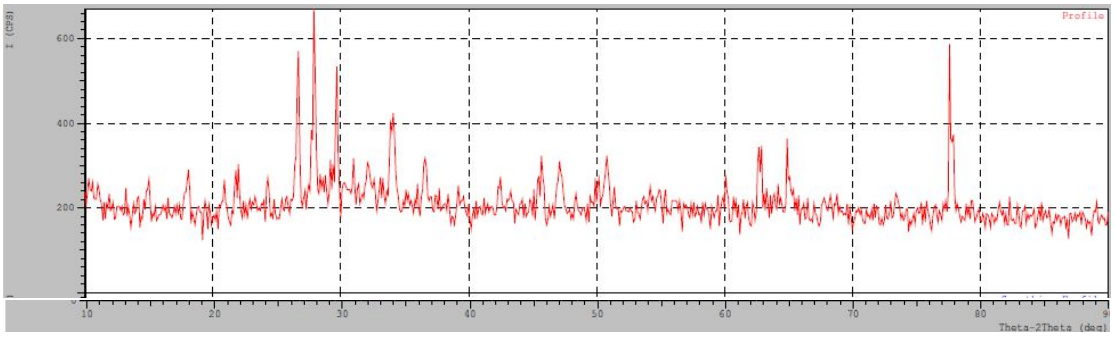

Figure 11 XRD (2 Θ angle) graph of M10

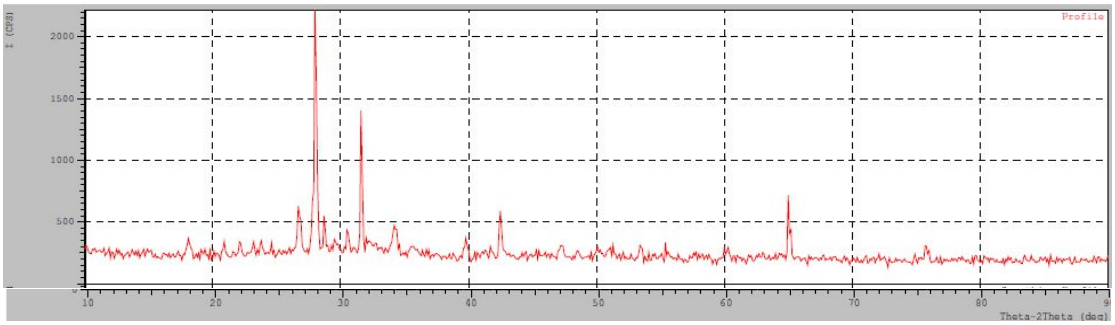

Figure 12 XRD (2 Θ angle) graph of M11

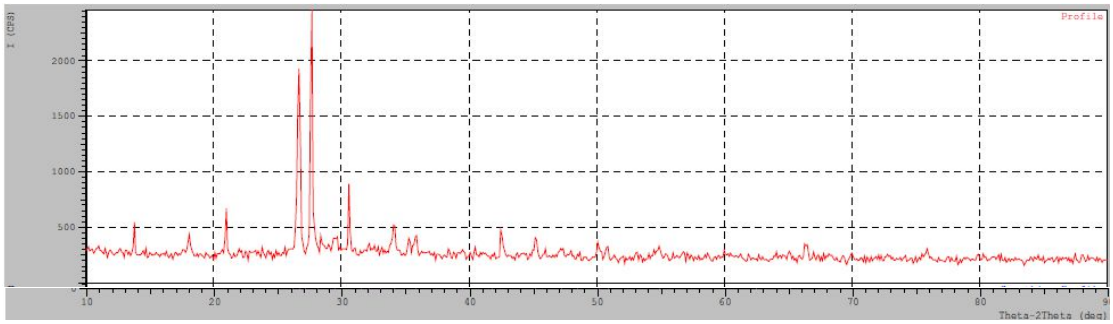

Figure 13 XRD (2 Θ angle) graph of M12

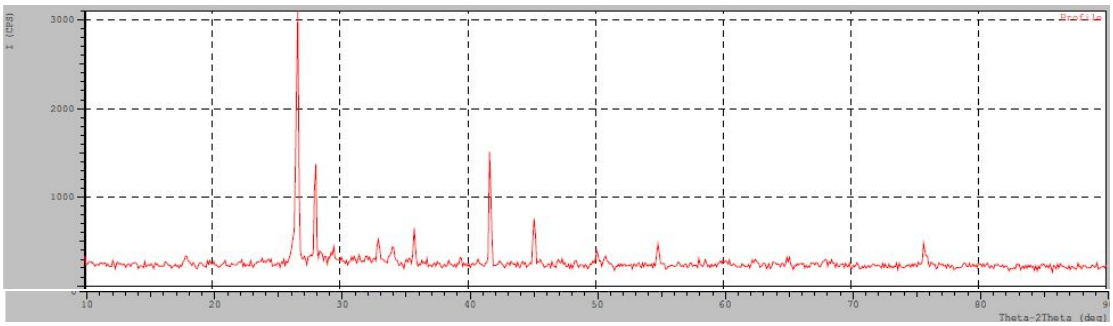

Figure 14 XRD (2 Θ angle) graph of M13

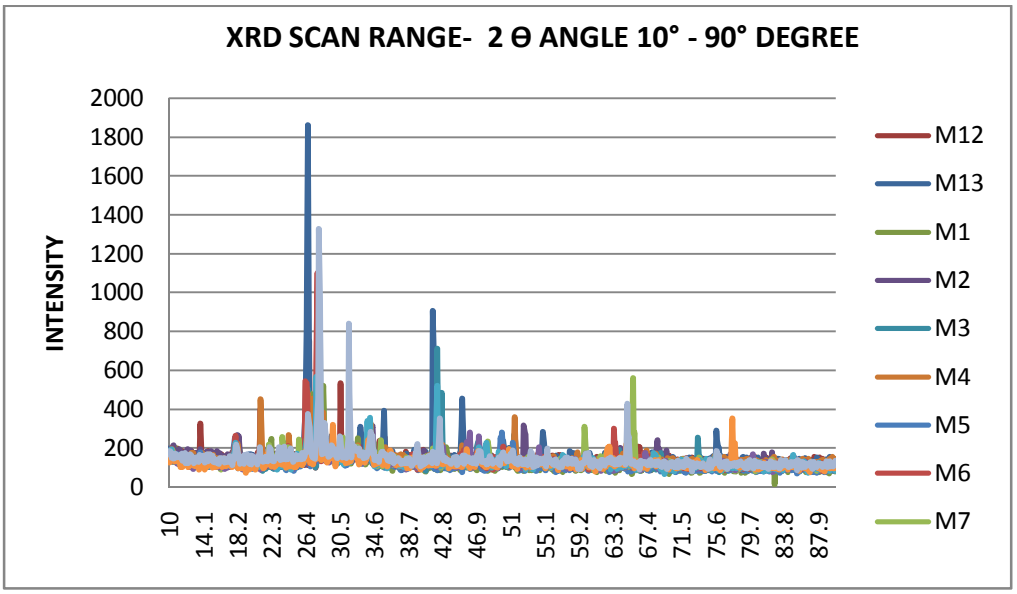

Figure 15 Combined XRD pattern (2 Θ angle) graph

The diffractogram in Fig.15. Gives the presence of the following phases:

- Ca3SiO5–alite, in majority in the sample (monoclinically crystallised, sheet PDF00-042-0551);
- Ca2SiO4–belite (monoclinically crystallised, sheet PDF00-033-0302);
- Ca3Al2O6-celite (cube crystallised, sheet PDF00-038-1429);
- Ca2(Al,Fe+3)2O5–brownmillerite (orthorhombic crystallised, sheet PDF00-030-0226).

4. CONCLUSION

The method of X-ray diffraction allowed the highlighting of the mineral components of the cement. In the time intervals under investigation the method used demonstrated the presence of hydration products (tobermorite, portlandite and ettringite) as well as the presence of other mineral compounds that will hydrate as time goes on. The continuous increase of the mechanical strengths of the cement can be explained by the hydration processes that never have an end. In general, the rate of pozzolanic reaction increased with silica fume and fly ash content in concrete. However, total C-S-H increased with fly ash addition up to 30% cement replacements. The concrete mixture with 7.5% SF and 15% FA cement replacement showed the highest rate of increase in concrete strength with age. The maximum compressive strength and tensile strength were obtained at respective cement replacements of 7.5% and 7.5% &15%.

REFERENCES

[1] R. Roychand, S. De Silva, D. Law, and S. Setunge" Micro and Nano Engineered High Volume Ultrafine Fly Ash Cement Composite with and without Additives" International Journal of Concrete Structures and Materials,Vol.10, No.1, pp.113–124, March 2016 .

[2] Meenamurmu and Suresh Prasad Singh" Hydration Products, Morphology and Microstructure of Activated Slag Cement" International Journal of Concrete Structures and Materials,Vol.8, No.1, pp.61–68, March 2014.

[3] JUMATE .Elena and MANEA Daniela Lucia "application of x ray diffraction (xrd) and scanning electron microscopy (sem) method to the portland cement hydration processes" Journal of Applied Engineering Science volume 2(15),Issue 1/2012

[4] Ye Qing , Zhang Zenan , Kong Deyu and Chen Rongshen "Influence of nano-SiO2 addition on properties of hardened cement paste as compared with silica fume" Construction and Building Materials 21 (2007) 539–545

[5] Gai-Fei Peng and Zhi-Shan Huang "Change in microstructure of hardened cement paste subjected to elevated temperatures" Construction and Building Materials 22 (2008) 593–599.

[6] Sidney Diamond "The microstructure of cement paste and concrete—a visual primer" Cément &Concrete Composites 26 (2004) 919–933.

[7] Yogesh Aggarwal and Rafat Siddique "Microstructure and properties of concrete using bottom ash and waste foundry sand as partial replacement of fine aggregates" Construction and Building Materials 54 (2014) 210–223.

[8] Malkit Singh and Rafat Siddique "Strength properties and micro-structural properties of concrete containing coal bottom ash as partial replacement of fine aggregate" Construction and Building Materials 50 (2014) 246–256.

[9] Yogesh Aggarwal and Rafat Siddique "Microstructure and properties of concrete using bottom ash and waste foundry sand as partial replacement of fine aggregates" Construction and Building Materials 54 (2014) 210–223.

[10] W.W.J. Chan*, C.M.L. Wu "Durability of concrete with high cement replacement, Cement and Concrete Research 30 (2000) 865±879

[11] Rafat Siddique "Effect of fine aggregate replacement with Class F fly ash on the mechanical properties of Concrete" Cement and Concrete Research 33 (2003) 539–547

[12] R.K.Kolisetty and H.S.Chore"Utilization of Waste Materials in Construction Activities: A Green Concept "International *conference on Green Computing and Technology, 2013.*

[13] P.KumarMehta,Paulo.J.M.Monteiro"Concrete Microstructure ,Properties and Materials" 3rd Edition,2006

[14] Ollivier JP, Maso JC, Bourdette B. Interfacial transition zone in concrete. Advanced Cem Mater 1995;1(2):30 –8.

[15] Bentur, I. Odler, Development and Nature of Interfacial Microstructure, RILEM Report 11, Interfacial Transition Zone in Concrete, E & FN SPON, 1996, 19–44.

[16] Scrivener KL, Pratt PL. Characterization of Interfacial Microstructure, RILEM Report 11, Interfacial Transition Zone in Concrete, E & FN SPON, 1996, 3–17

[17] Monteiro PJM, Mehta PK. Interaction between carbonate rock and cement paste. CemConcr Res 1986; 16:127 –34.

[18] Magudeaswaran.p ,Eswaramoorthi.P" Durability Characteristics of Composite by the Partial Replacement of Binding Material" Journal of Computational and Theoretical Nanoscience Vol. 13, 5389–5393, 2016

[19] Zhang MH, Gjo,rvOE. Microstructure of the interfacial zone between lightweight aggregate and cement paste. CemConcrRes 1990;20:610 –8.

[20] Sarkar SL, Chandra S, Berntsson L. Independence of microstructure and strength of structural lightweight aggregate concrete. Cem Concr Compos 1992;14:239 –48.

[21] N. Balasundaram , S. Paulraj, "Experimental Studies on Strength and SCC Characteristics of Basalt Fiber Reinforced Concrete" *International Journal of Civil Engineering and Technology (IJCIET),* Volume 8, Issue 1, pp. 704–711

[22] Biswajit Jena and Asha Patel, Study on the Mechanical Properties and Microstructure of Chopped Carbon Fiber Reinforced Self Compacting Concrete, *International Journal of Civil Engineering and Technology,* 7(3), 2016, pp. 223–232